CRUISE RESULTS
NOAA SHIP MILLER FREEMAN
Cruise No. 89-02
Echo Integration/Midwater Trawl Survey
of Spawning Pollock in the Gulf of Alaska

CRUISE PERIOD, AREA AND SCHEDULE

The NOAA R/V Miller Freeman conducted an echo integrator/midwater trawl survey of walleye pollock (Therasra chalcosramma) in the Gulf of Alaska. Survey operations commenced on March 11, 1989, and were completed on April 1. The vessel's itinerary was as follows:

Mar 11	Depart Dutch Harbor, AK.
Mar 11-13	Davidson Bank survey.
Mar 13	Transit to Shelikof Strait.
Mar 14-19	Shelikof Strait survey 1.
Mar 19-20	Nearshore survey inside Shelikof Strait.
Mar 21-22	Standard sphere calibration in Malina Bay.
Mar 22-23	Line 8 CTD's. Transit to area south of Chirikof Island.
Mar 23-26	Chirikof Island survey.
Mar 27-30	Shelikof Strait survey 2.
Mar 30-31	Marmot Bay survey.
Apr 1	Arrive Kodiak, AK.

OBJECTIVES

Echo integration/midwater trawl surveys have been conducted in the Gulf of Alaska annually since 1980 (with the exception of 1982). These surveys have focused on the spawning pollock in Shelikof Strait. The principal objectives of this cruise were to:

1. Collect echo integrator and midwater trawl data necessary to determine the distribution, biomass, and biological composition of spawning pollock in selected areas of the Gulf of Alaska - including Shelikof Strait, Davidson Bank,

Marmot Bay, and the region south and east of Chirikof Island.

2. Collect measurements of a standard sphere to provide calibration information about the acoustic system and to detect changes in system performance wih changes in transducer depth.

3. Collect biological samples of pollock for reproduction and stock structure studies.

4. Collect trawl configuration data for the midwater rope trawl using Scanmar[1] trawl mensuration gear.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

The survey was completed on board the NOAA Ship Miller Freeman, a 66 m stern trawler equipped for fisheries and oceanographic research. The acoustic system used during this cruise was an echo integration system operating at 38 kHz. The transducer, housed in a dead-weight fin, was towed at a depth of 12-15 m below the surface. System electronics were housed in a van mounted to the weather deck of the vessel. Echo data were processed using a Hewlett Packard 1000 computer.

Echo sign was sampled using a modified Northern Gold 1200 midwater rope trawl (NET Systems, Inc.). The trawl, which had ropes in the forward section and mesh sizes ranging from 64 inch (163 cm) forward to 3.5 (8.9 cm) inch in the cod end, was outfitted in a bridle-less configuration, with 5 m^2 doors and a 1-1/4 inch (3.125 cm) mesh cod end liner. In Hauls 1-7, the tom weights were each 1000 lbs (455 kg). One chain was lost during Haul 7, so backup links were combined to yield a pair of 800-lb (395 kg) tom weights used for the remainder of the cruise. Trawl mouth opening and depth were monitored with either a Simrad third-wire netsounder system or a Furuno wireless system mounted to the headrope of the trawl. In addition to the ship's netsounder, the Scanmar net mensuration gear was attached to the trawl on selected tows. The Scanmar gear includes a headrope sensor, two wingspread sensors, and a depth sensor.

Water temperature/conductivity profile data were collected at each trawl site and other selected locations using a Seabird CTD system. Additional information was obtained by deploying XBT[1]s. Surface temperatures were measured with a bucket thermometer.

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[1] Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service (NMFS), NOAA.

SURVEY METHODS

Survey work began in the Davidson Bank area with a set of six transect lines oriented roughly north–south and covering the shelf from 166°00'W to 162°30'W between the 40 and 200 fm bottom depth contours. From there, the vessel transited to the southern end of Shelikof Strait.

The first pass through Shelikof Strait began just south of the Semidi Islands (55°30'N) and proceeded northward to just off Shuyak Island (58°35'N). The trackline consisted of parallel transects traversing the Strait between the 40 fm bottom depth contours. The spacing between transects was 10 nmi.

The next area to be surveyed was a region south and east of Chirikof Island. Transect lines oriented perpendicular to the shelf covered an area bounded by the 100 and 500 fm bottom depth contours and 157°30'W and 154°00'W. The first few transects were spaced at 10 nmi with subsequent lines spaced at 5 nmi.

Upon completion of the survey near Chirikof Island, the vessel returned to Shelikof Strait for a second pass which began at 56°00'N and continued north to Shuyak Island. Transect lines were spaced at 10 nmi and offset 5 nmi north of the first set of transects.

The last days of the cruise were spent exploring Marmot Bay. The area east of the Marmot Bay shoal from 151°30'W to 152°10'W between the 50 fm bottom depth contours was surveyed with north-south lines spaced 3 nmi apart. Inside the bay, zig-zag transects covered waters deeper than 50 fm, including Monashka Bay, Izhut Bay, Spruce Gully, and the area west of the Triplets.

Survey operations were conducted both day and night. Vessel speed varied between 6 and 12 knots depending upon weather conditions. Echo integrator density estimates were computed at 1 minute intervals for each 1 m depth stratum between the transducer and the bottom. These 1 m values are summed over the water column to provide estimates of surface density (kg/m^2). Midwater trawl hauls were made at selected locations to identify echo sign and provide biological samples. The average trawling speed was about 3 knots. Standard catch sorting and biological sampling procedures were used to provide estimates of weight and number by species for each haul. Walleye pollock were further sampled to determine sex, length, weight, age, maturity, ovary weight, and stomach composition. Other pollock samples were preserved for reproduction and stock structure studies.

The standard sphere calibration was conducted in Malina Bay on the west side of Afognak Island. The vessel was anchored fore and aft in ~100 m of water. Calibration involves suspending a copper sphere with known acoustic properties below the fin and lowering the fin through the water column to determine changes in system performance with transducer depth.

PRELIMINARY RESULTS

Trawl station and catch data from the 26 midwater trawl hauls are summarized in Table 1. Total catch numbers and weight for each species taken are shown in Table 2. A tally of the biological data collected for pollock is presented in Table 3. A total of 23 CTD casts (Table 4) and 21 XBT casts (Table 5) were made.

Davidson Bank survey

The vessel surveyed the Davidson Bank shelf area from March 11 - 13 (Fig. 1). Trackline mileage totalled 300 nmi. No significant pollock echo sign was detected. No trawls were made. Our decision to survey the shelf area had been based on survey data from previous years which showed concentrations of eggs and larvae on the shelf, as well as an April 1988 report of spawning pollock schools on Sanak Bank. Subsequently, we received reports from the fishing fleet that spawning pollock were being caught off the shelf south of Sanak Island in much deeper water.

Shelikof Strait surveys 1 and 2

Two surveys of Shelikof Strait were conducted in March. The first pass from March 14-19 totalled approximately 900 nmi of trackline with 16 midwater trawl hauls (Fig. 2). The second pass from March 27-30 totalled approximately 700 nmi with 5 midwater trawl hauls (Fig. 3). Immediately after the first pass, the nearshore areas between Cape Nukshak (58° 20'N) and Katmai Bay (57° 55'N) on the Peninsula side and Cape Karluk (57° 35'N) and Cape Paramanof (58° 15'N) on the Kodiak Island side were resurveyed at 4 nmi spacing (Fig. 4). During Pass 1, fish sign was first encountered on Transect 105 and last detected on Transect 120. This geographic distribution was relatively unchanged during Pass 2. The highest densities of pollock for both surveys were encountered off Cape Ugyak.

Three types of echo sign were identified in the Strait, representing 1) high density schools in the upper 50 fm of the water column (Fig. 5), 2) a 5 fm thick midwater layer at a depth of 95 fm (Fig. 6), and 3) near bottom sign within 20 fm of bottom (Fig. 6). The pollock in these 3 types of fish concentrations differed from each other both in size (Fig. 7) and maturity stage (Fig. 8). Pollock in the upper layer ranged from 30 to 45 cm in length with approximately 95% of the females categorized as immature/developing. In the midwater layer, we found several age classes of pollock; age 1's (9-16 cm), age 2's (17-27 cm), and age 3+ (28-45 cm). Approximately 90% of the females > 26 cm were classified as immature/developing. Size composition in the near bottom layer was similar to the midwater layer in that it covered several year classes, but there were fewer age 1 fish and a significant number of fish > 45 cm. Over 50% of the females > 26 cm were in spawning condition (i.e. mature, spawning, or spent).

The only spawning or spent females encountered during either pass of the Strait were found in the spawning school off Cape Ugyak on March 30.

Chirikof Island survey

Responding to reports from the fishing fleet, we surveyed the .off-shelfarea south and east of Chirikof Island from March 23-26 (Fig. 9). We encountered the two schools of spawning pollock mentioned in the fishing fleet reports, one at 55°05'N 156°40'W and a second at 55°55'N 154°30'W, and delineated the school boundaries. Total trackline mileage in this area was approximately 500 nmi. Some fish sign was detected on each transect, but densities were relatively low compared to those measured in the schools.

School 1, at 55°05'N 156°40'W, was approximately 4 X 1 nmi in size and 25 fm thick. School 2, at 55°55'N 154°30'W, was 11 X 4.5 nmi in size and 25 fm thick. Both concentrations of fish were located at a depth of 200 fm in the water column. The densities measured in school 1 were much higher than those in school 2. Pollock in both schools ranged in length from 40 to 60 cm with an average length of 50 cm (Fig. 10). Catches from the 3 trawl hauls were dominated by female fish at a ratio of about 2 to 1. The fraction of spawning and spent females in school 2 was higher than in school 1 indicating that spawning had occurred there first (Fig. 11).

Marmot Bay survey

Approximately 200 nmi of trackline were surveyed in the Marmot Bay area on March 30-31 (Fig. 12). The only pollock detected were found in Spruce Gully and in a small area east of Marmot shoal. The school in Spruce Gully was located at 110 fm in the water column, approximately 35 fm off bottom. The fish ranged in size from 31 to 65 cm with an average length of 44 cm (Fig. 13A). The catch from our single trawl haul was 70% female. Approximately half of these females were immature/developing, and among the remaining mature females, most had not yet spawned (Fig. 13B). East of Marmot shoal at 57° 57'N 151° 59W, a low density concentration of pollock was found at a bottom depth of 115 fm. The fish were found scattered within 40 fm of the bottom. Fish ranged in length from 35 to 65 cm with an average length of 44 cm (Fig. 14A). The catch was male-dominated (only 31% female). Most of the females here were mature (Fig. 14B) and some extruded eggs when pressure was applied to the abdomen.

Standard sphere calibration

A calibration of the acoustic system using a standard copper sphere was conducted in Malina Bay on March 21 and 22. There

were very few fish in the bay, so fish interference was not a problem. Data were collected with the transducer positioned at selected depths between 2 and 30 meters. Preliminary results from this calibration agree well with measurements made during the previous calibrations on February 13-14 and March 8. The weather during calibration was not ideal, resulting in a little more variability in the data. The data indicate an increase in total system sensitivity with increasing depth (Fig. 15). System sensitivity is approximately 1 dB higher at the fin tow depth of 15 m than at the APL (Applied Physics Lab.) barge calibration depth of 2 m. System response increases by a factor of 2 when the transducer is lowered from 2 m down to 30 m. Results are relatively stable for the first 10 meters. Target strength measurements during transducer ascent seem to lag behind those observed during descent indicating historesis in the transducer.

Trawl mensuration

The Scanmar net mensuration gear was attached to the trawl on 14 of the 26 midwater tows. The headrope sensor never worked, although we tried positioning it in several different places on the net and added floats to the footrope to make it a better reflector. The wingspread sensor operated successfully on most tows. The depth sensor was employed in place of the headrope and wingspread units on the last 6 tows and produced data that were in close agreement with the ship's netsounder system. The ship's third wire netsounder system measured vertical openings from 11 to 16 fm (average = 13 fm) for tows with a footrope depth < 100 fm. For tows with a footrope depth >= 100 fm, the vertical openings ranged from 14 to 23 fm, with an average opening of 19 fm. For the last 2 tows in Marmot Bay, the Furuno wireless netsounder system was used. Though the footrope depth on both tows was ~ 100 fm, the vertical openings measured were uncharacteristically small, only 8 fm and 9 fm. There were no obvious problems detected with the trawling operations to explain this decrease in net opening.

SCIENTIFIC PERSONNEL

Neal Williamson	Chief Scientist	NWAFC
Daniel Twohig	Electronics Technician	NWAFC
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Table 1. Midwater trawl station and catch data, MF89-2.

HAUL NO	AREA	DATE (1989)	TIME (AST)	START POSITION LAT. (N)	START POSITION LONG. (W)	TEMP. (C) SURF	TEMP. (C) GEAR	DEPTH (FM) GEAR	DEPTH (FM) BOTT	CATCH (LBS/NOS) WALLEYE POLLOCK	CATCH (LBS/NOS) EULACHON	CATCH (LBS/NOS) OTHER
1	S1	15 MAR	0930-0941	56 38.0	156 12.0	2.3	***	129	135	474/416	14/226	30/11
2	S1	15 MAR	1049-1107	56 37.7	156 10.9	2.3	***	99	161	25/508	2/72	1/1
3	S1	15 MAR	1800-1821	56 43.8	155 50.2	2.8	3.0	112	161	693/655	0	1/1
4	S1	15 MAR	1939-1956	56 43.6	155 50.4	2.8	4.2	146	163	1805/7010	61/796	13/6
5	S1	16 MAR	0503-0518	56 48.1	155 21.5	2.2	3.9	109	130	470/3338	1/39	7/13
6	S1	16 MAR	1324-1344	57 2.2	155 28.4	2.8	5.4	142	152	1312/1406	436/6328	5/10
7	S1	16 MAR	1557-1612	56 0.0	155 25.1	2.8	2.6	90	150	724/1843	14/601	3/4
8	S1	17 MAR	0537-0557	57 16.8	154 57.5	2.3	2.2	38	108	3210/3142	0	17/3
9	S1	17 MAR	1414-1435	57 35.1	155 16.7	2.1	5.4	145	164	1839/1806	683/10180	56/35
10	S1	17 MAR	1620-1631	57 34.0	155 14.3	2.1	3.1	69	150	108/127	3/33	1/2
11	S1	18 MAR	0831-0855	57 53.4	154 0.1	2.1	3.2	44	113	544/771	1/13	14/16
12	S1	18 MAR	1155-1158	58 0.7	154 18.0	2.4	5.4	138	154	6852/8042	38/752	126/20
13	S1	18 MAR	1442-1453	57 58.8	154 36.8	2.1	5.2	134	148	7946/7505	23/507	13/15
14	S1	18 MAR	2241-2244	58 12.8	154 3.7	2.1	2.8	112	146	1208/1680	19/363	30/16
15	S1	19 MAR	0507-0527	58 14.4	153 19.5	2.0	3.1	81	122	1638/2288	7/192	13/7
16	S1	19 MAR	1121-1154	58 14.0	153 56.1	0.8	3.0	126	142	8567/9777	524/6423	16/17
17	CH	24 MAR	0420-0438	55 10.0	156 37.0	3.8	4.7	184	294	274/150	0	64/11
18	CH	24 MAR	2152-2203	55 9.0	156 33.0	3.8	4.6	160	380	1217/526	0	381/86
19	CH	26 MAR	1208-1232	55 56.2	154 22.9	4.4	4.5	227	380	6040/2930	0	100/30
20	S2	27 MAR	1805-1833	56 36.2	155 39.0	2.7	3.6	111	127	2395/5200	0	0
21	S2	28 MAR	1433-1453	57 17.6	155 25.2	2.6	5.4	138	144	5039/5178	2968/22613	147/60
22	S2	28 MAR	1644-1654	57 18.3	155 29.3	2.8	3.0	53	153	1186/1794	0	6/2
23	S2	28 MAR	1135-1143	57 41.0	154 21.0	2.7	2.5	46	99	6369/8317	0	43/6
24	S2	30 MAR	0045-0047	58 12.5	154 2.4	3.0	4.9	146	160	5791/5337	106/837	0
25	MB	31 MAR	1324-1359	57 59.0	152 19.0	3.4	3.5	102	150	2392/1560	0	15/1
26	MB	1 APR	0127-0143	57 56.7	151 58.7	3.3	3.4	102	114	1011/692	0	31/6

AREAS

S1 = SHELIKOF PASS 1
CH = CHIRIKOF ISLAND
S2 = SHELIKOF PASS 2
MB = MARMOT BAY

able 2. Tota catch numbers and weight by species, MF89-2.

Species	Total Catch			
	Numbers	Percent	Pounds	Percent
Walleye pollock (Theragra chalcogramma)	85193	63	68847	92
Eulachon (Thaleichthys pacificus)	49975	36	4794	6
Giant grenadier (Albatrossia pectoralis)	91	<.1	429	.5
Arrowtooth flounder (Atheresthes st ias)	58	<.1	137	<.1
S ooth lumpsucker (Aptocyclus ventricosus)	46	<.1	100	<.1
Squid (unidentified)	40	<.1	61	<.1
Cinook sal n (Oncorhynchus tshawytscha)	27	<.1	48	<.1
ellyfish (unidentified)	22	<.1	18	<.1
Pacific cod (Gadus macrocephalus)	21	<.1	147	<.1
Rougheye rockfish (Sebastes aleutianus)	13	<.1	28	<.1
Shrimp (unidentified)	12	<.1	<1	<.1
Shortraker rockfish (Sebastes borealis)	10	<.1	40	<.1
Flathead sole (Hippoglossoides robustus)	7	<.1	3	<.1
Rock sole (Lepidopsetta ilineata)	7	<.1	10	<.1
Pacific herring (Clupea pallasi)	5	<.1	<1	<.1
Ragfish (Icosteus aeniqmaticus)	3	<.1	76	<.1
Myctophids (Myctophidae)	2	<.1	<1	<.1
Brown Irish lord (Hemilepidotus spinosus)	1	<.1	<1	<.1
Totals	135533	100	74439	100

Table 3. Summary of the numbers of biological samples and measurements, MF89-2.

HAUL NO	LENGTH	MATUR.	OTOLITHS	FISH WGTS	OVARY WGTS	STOMACH SCANS	STOCK STRUCTURE FROZEN FISH	STOCK STRUCTURE OVARIES	REPRODUCTION MATUR.	REPRODUCTION FECUNDITY	REPRODUCTION ATRESIA
1	466	84	84	84	39	0	0	0	0	0	0
2	112	0	0	0	0	0	0	0	0	0	0
3	691	138	0	0	0	20	0	0	0	0	0
4	556	98	98	98	0	20	50	0	0	0	0
5	334	78	78	0	0	0	0	0	0	0	0
6	658	50	50	0	0	0	0	0	50	0	0
7	553	101	0	0	0	0	0	0	0	0	0
8	279	98	98	98	49	0	0	0	0	0	11
9	476	100	100	100	28	0	0	0	0	24	0
10	127	123	0	0	0	0	0	0	0	0	0
11	281	86	86	86	0	0	0	0	0	0	2
12	321	159	82	82	12	0	0	0	0	0	0
13	429	103	103	103	28	0	0	0	0	17	0
14	315	80	0	0	0	0	0	0	0	0	0
15	416	96	96	0	0	0	0	0	0	0	0
16	512	108	108	108	40	0	0	0	0	0	17
17	150	93	93	93	35	0	50	0	0	0	0
18	326	79	79	79	39	0	0	48	0	0	0
19	293	94	94	94	48	0	0	0	0	0	0
20	671	129	0	0	0	30	0	0	0	0	5
21	302	64	63	64	16	0	0	0	34	0	0
22	211	98	0	0	0	0	0	0	16	0	0
23	350	100	15	0	0	0	0	0	0	5	0
24	346	81	81	81	27	0	0	0	0	0	14
25	302	77	77	77	23	0	50	48	0	0	0
26	247	91	91	91	35	0	0	0	0	0	0
TOTAL	**9724**	**2408**	**1576**	**1338**	**419**	**70**	**150**	**96**	**100**	**46**	**49**

Table 4. **Inventory of CTD casts, MF89-2.**

CAST	HAUL	DATE	TIME (AST)	POSITION LAT.	POSITION LONG.	DEPTH (m)	STRATUM	COMMENT
1	1	89 315	1151	5637.8	15609.0	275	1	HAULS 1 & 2
2	3	89 315	2045	5645.2	15553.7	311	1	HAULS 3 & 4
3	5	89 316	0622	5648.1	15522.4	242	1	HAUL 5
4	6	89 316	1818	5702.2	15527.5	278	1	HAULS 6 & 7
5	8	89 317	0654	5717.1	15458.0	192	1	HAUL 8
6	9	89 317	1743	5735.0	15516.3	293	1	HAULS 9 & 10
7	11	89 318	0951	5753.4	15400.5	209	1	HAUL 11
8	12	89 318	1257	5800.5	15418.4	282	1	HAUL 12
9	13	89 318	1551	5755.7	15438.4	262	1	HAUL 13
10	14	89 318	2340	5812.8	15403.6	170	1	HAUL 14
11	15	89 319	0624	5815.1	15318.5	211	1	HAUL 15
12	16	89 319	1347	5816.1	15355.0	260	1	HAUL 16
13		89 321	1444	5812.8	15302.3	80	1	BALL CAL
14		89 321	2221	5812.8	15302.3	72	1	BALL CAL
15	17	89 324	0550	5509.9	15636.3	500	3	HAUL 17
16	18	89 324	2342	5508.9	15635.4	500	3	HAUL 18
17	19	89 326	1337	5555.8	15421.6	500	3	HAUL 19
18	20	89 327	1937	5637.1	15540.8	250	2	HAUL 20
19	21	89 328	1743	5718.9	15529.4	269	2	HAULS 21 & 22
20	23	89 329	1300	5741.0	15420.7	171	2	HAUL 23
21	24	89 330	0141	5812.2	15402.6	283	2	HAUL 24

Table 5. Inventory of XBT casts, MF89-2.

CAST	HAUL	DATE	TIME (GMT)	POSITION LAT	POSITION LONG	DEPTH (m)	STRATUM	COMMENT
1	0	89 312	2155	5352.2	16346.2	83	0	S. END T4
2	0	89 313	0008	5356.7	16312.7	550	0	S. END T5
3	0	89 313	2352	5420.7	16000.0	360	0	
4	0	89 314	0606	5453.1	15818.0	200	0	
5	0	89 314	1416	5533.0	15613.4	214	1	MID T101
6	0	89 315	0132	5607.6	15620.5	222	1	MID T104
7	0	89 315	0642	5617.1	15613.2	260	1	MID T105
8	0	89 317	0446	5704.8	15543.4	295	1	MID T110
9	0	89 317	1859	5722.2	15529.7	295	1	MID T112
10	0	89 318	1928	5532.7	15406.7	208	1	MID H-11 & H-12
11	0	89 320	0235	5824.4	15313.1	175	1	S. END T121
12	0	89 320	1828	5748.0	15430.0	225	1	MID T811 T901
13	0	89 322	1907	5758.5	15352.2	205		
14	0	89 324	0352	5457.8	15706.1	841	3	MID T302
15	0	89 325	0926	5509.1	15634.2	625	3	N. END T315
16	0	89 326	0331	5548.3	15459.2	275	3	N. END T315
17	0	89 326	0ƎdZ	5543.5	15352.7	1650	3	MID T321
18	0	89 327	2116	5631.5	15604.8	264	2	MID T206
19	0	89 ƎZ9	0406	5715.9	15517.1	222	2	MID T211
20	0	89 330	0011	5750.8	15412.3	183	2	MID T216
21	0	89 330	1918	5828.0	15308.0	166	2	MID T221

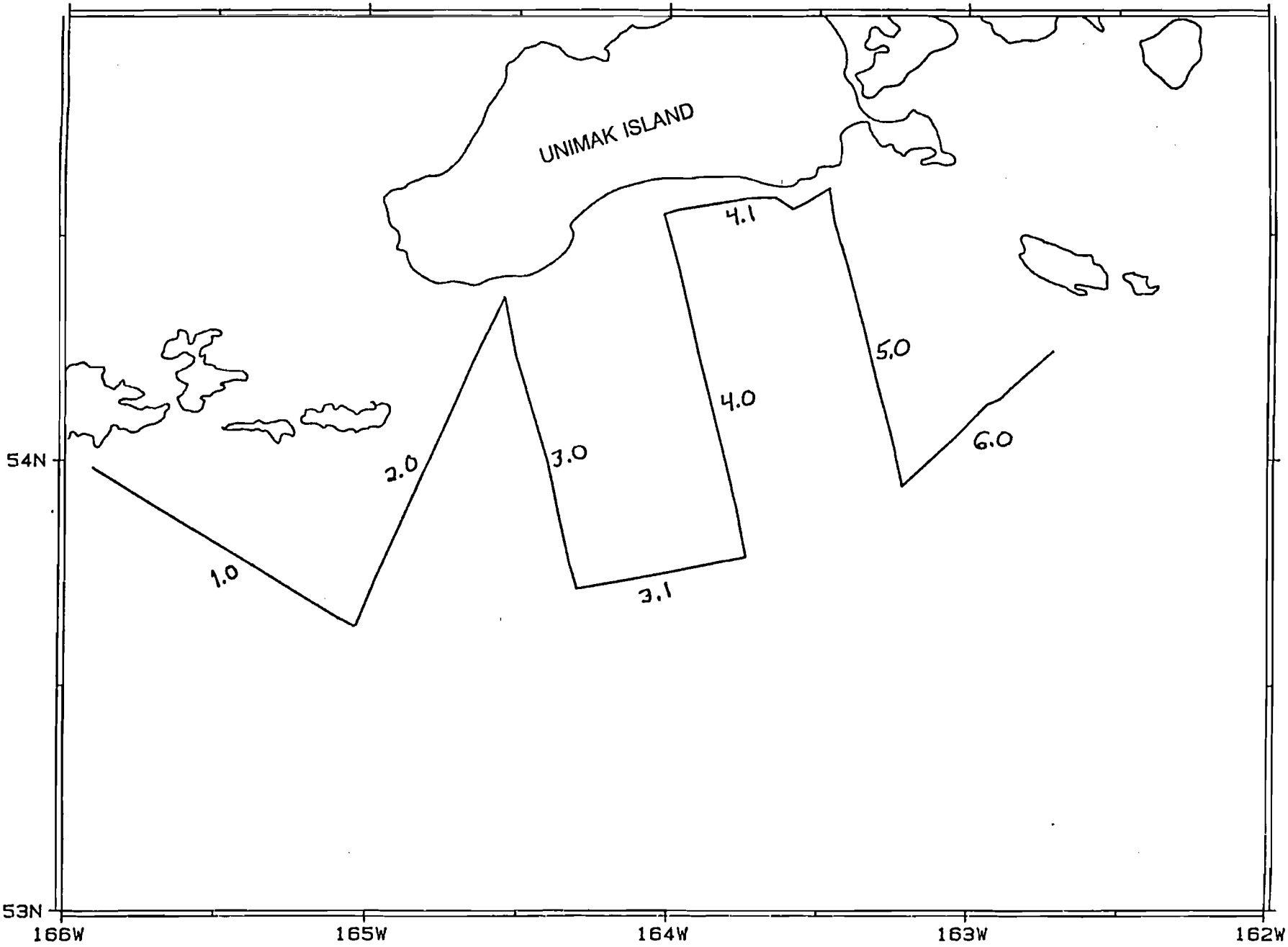


Figure 1. Davidson Bank survey trackline MF89-2

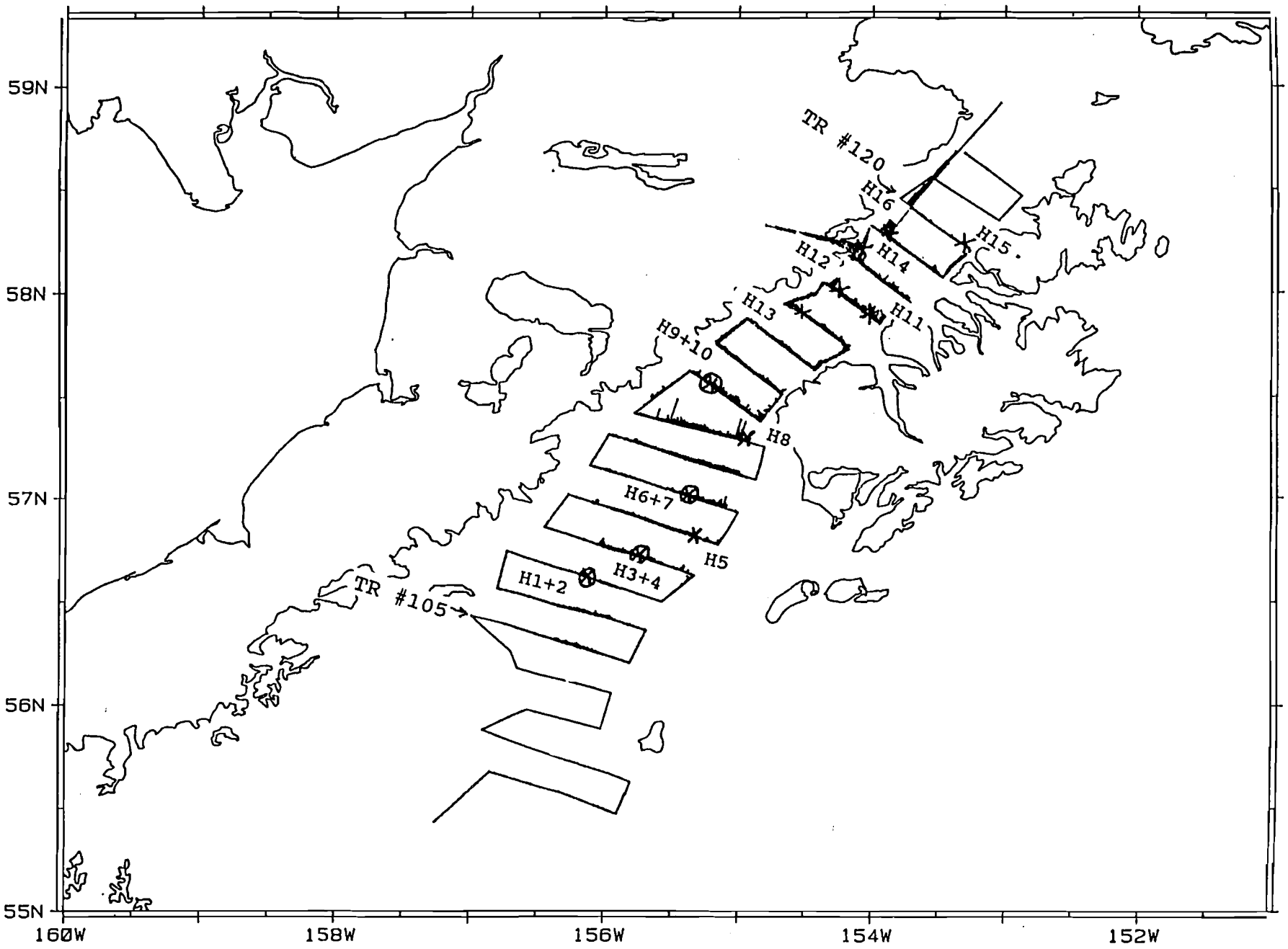


Figure 2. Shelikof Strait (pass 1) survey trackline and midwater trawl stations, MF89-2. Deflections off transect lines indicate relative fish density.

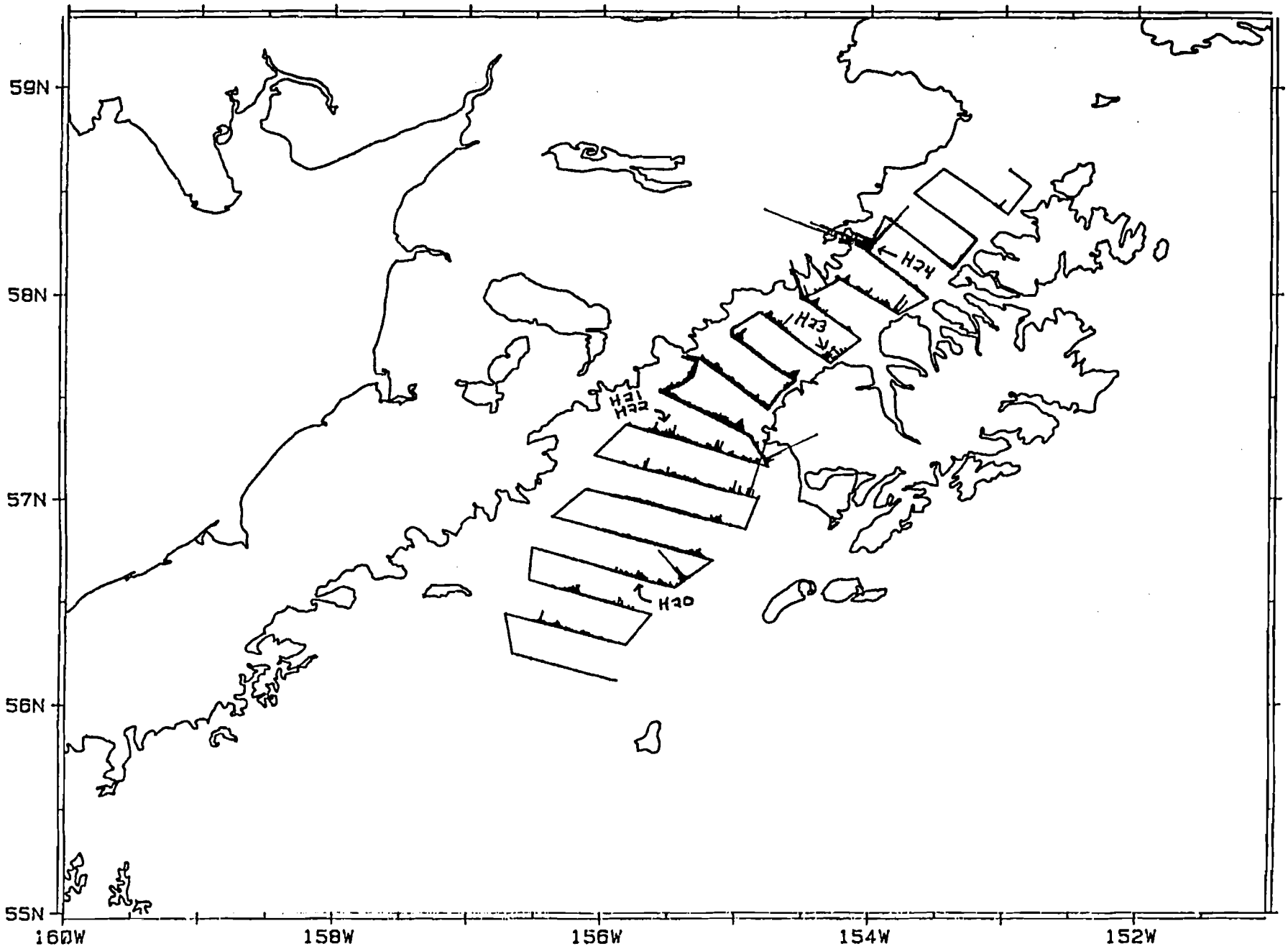


Figure 3. Shelikof Strait (pass 2) survey trackline and midwater trawl stations, MF89-2. Deflections off transect lines indicate relative fish density.

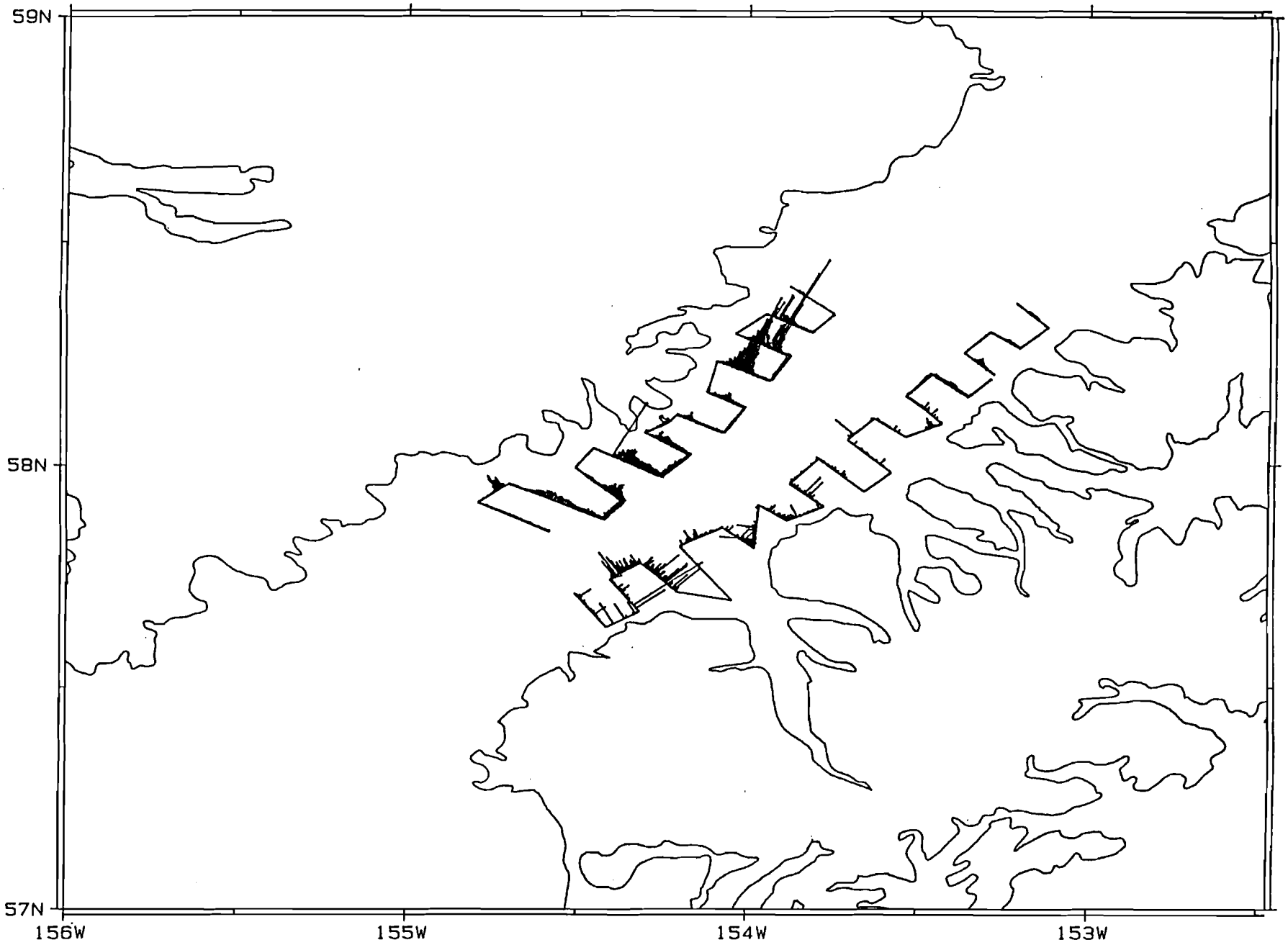


Fig. 4. Survey trackline of nearshore areas inside Shelikof Strait, MF89-2.

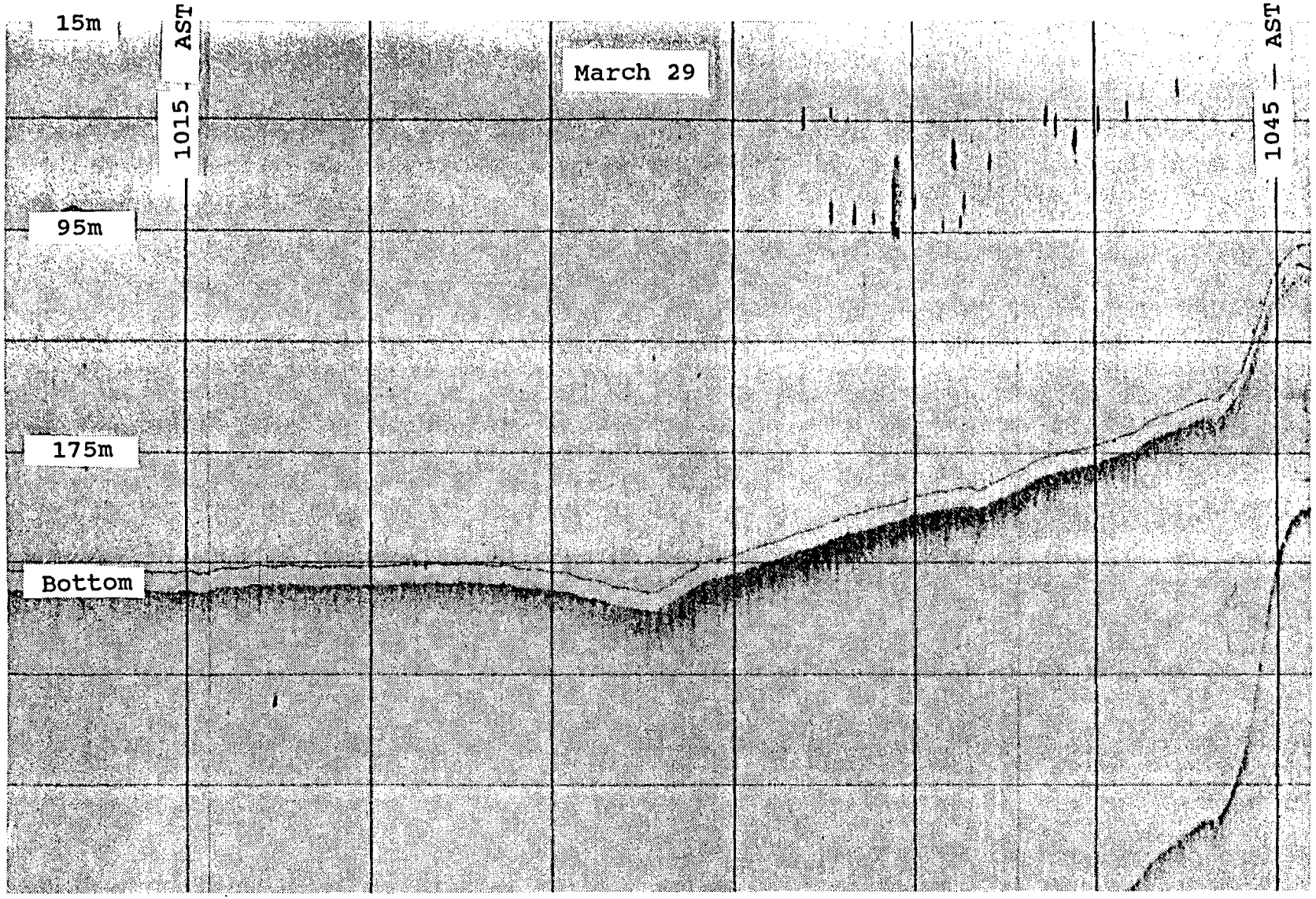


Figure 5. Upper layer pollock echo sign from Shelikof Strait, MF89-2.

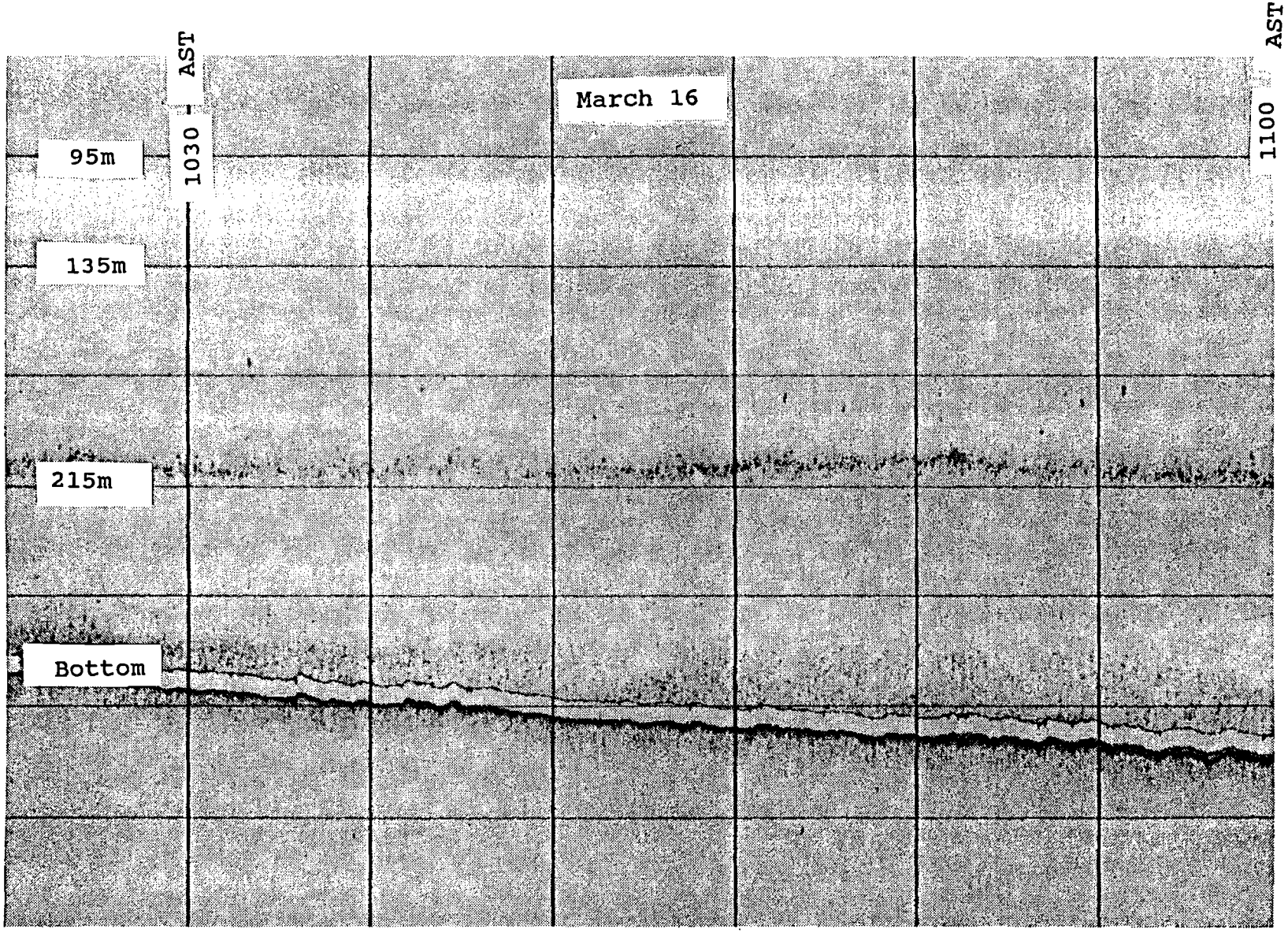


Figure 6. Midwater layer and near bottom pollock echo sign from Shelikof Strait, MF89-2.

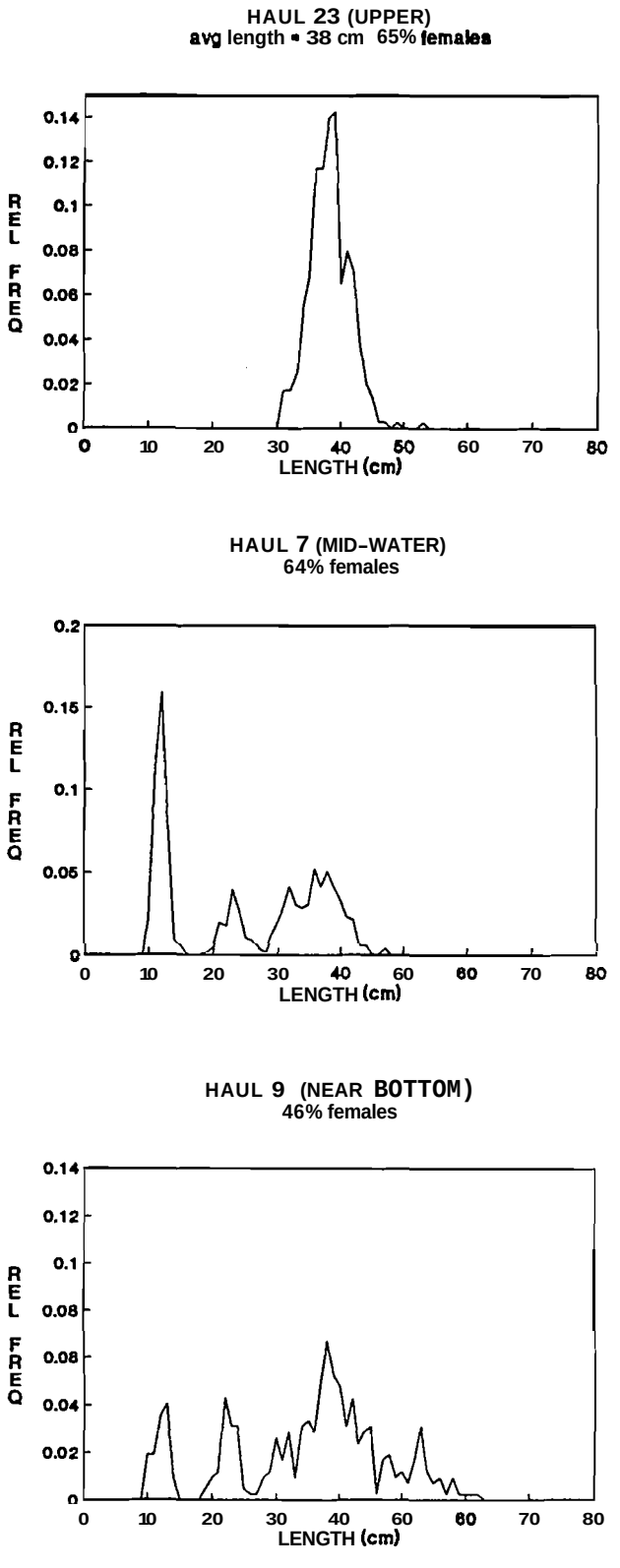


Figure 7. Representative length compositions for three types of pollock echo sign from Shelikof Strait, MF89-2.

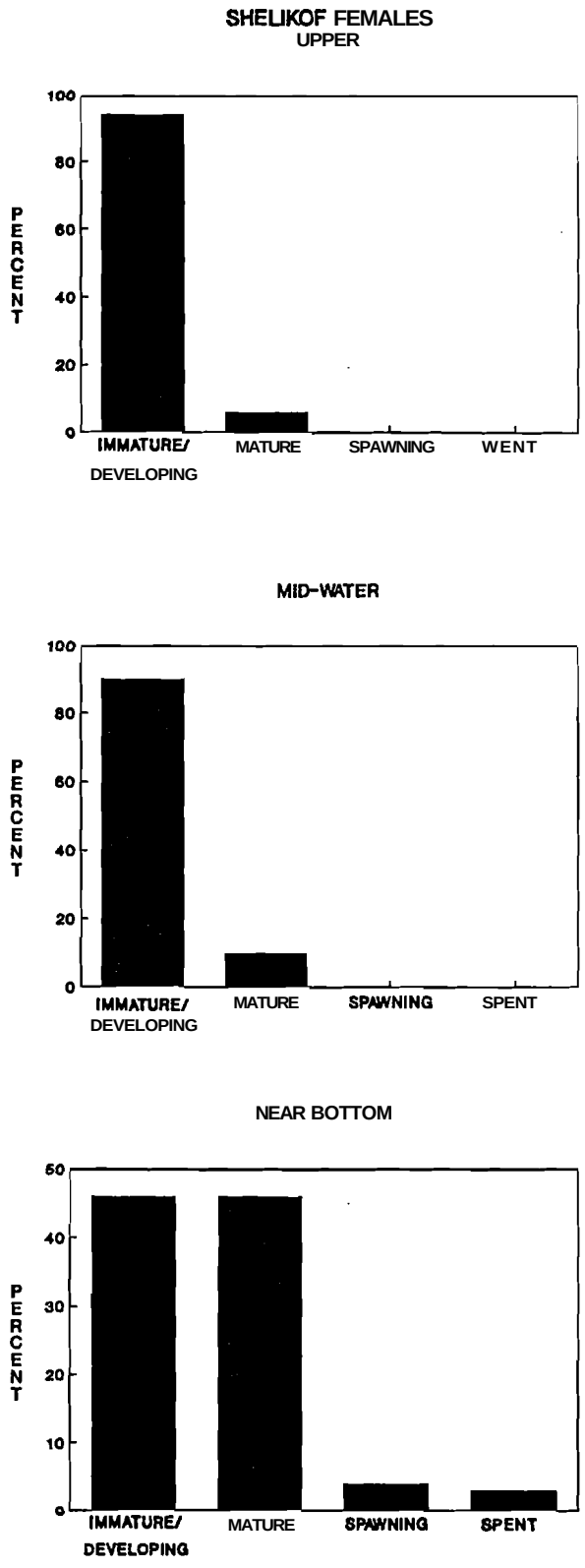


Figure 8. Representative female maturity compositions for three types of pollock echo sign from Shelikof Strait, MF89-2.

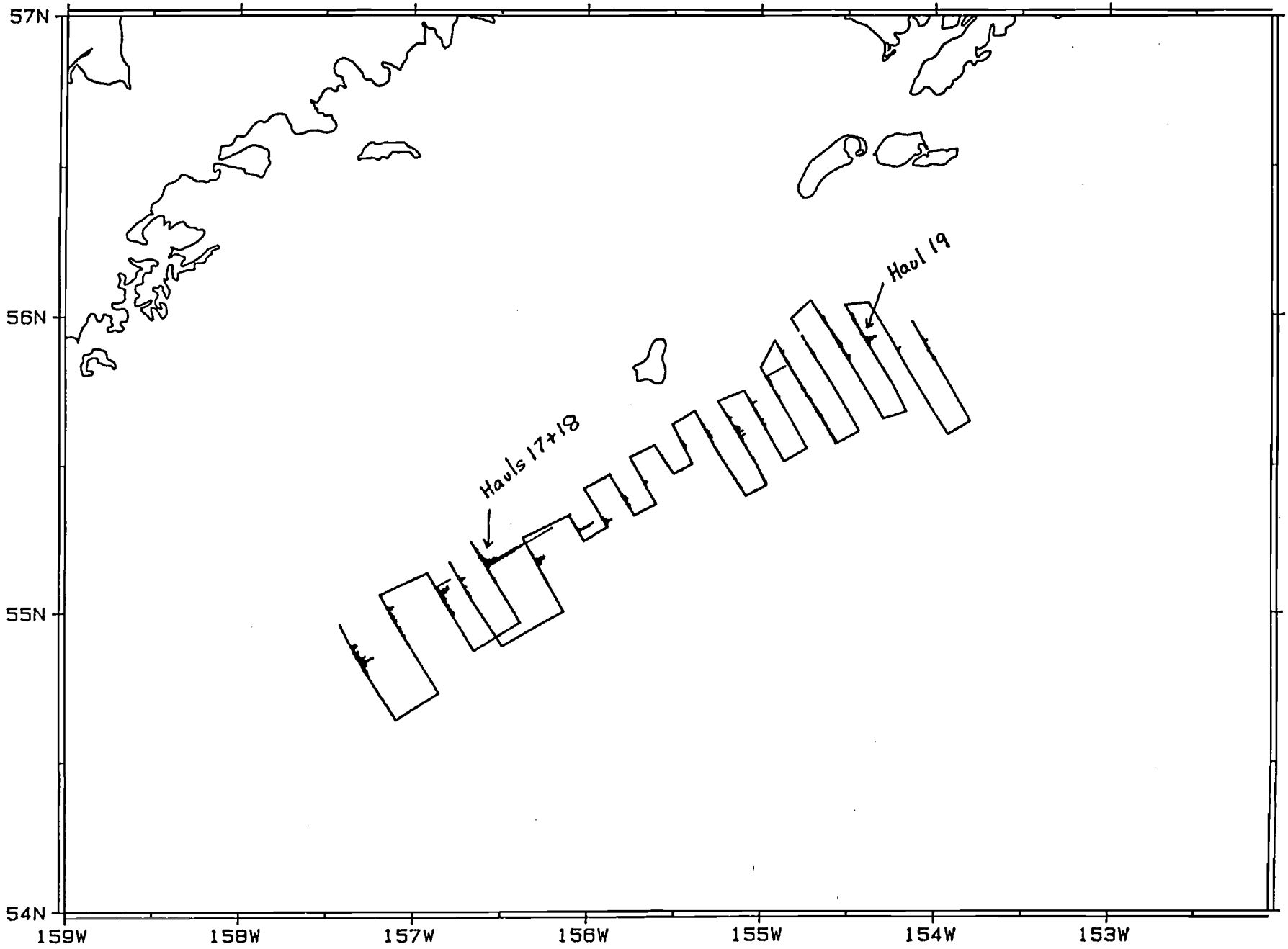


Figure 9. Chirikof Island survey trackline and midwater trawl stations, MF89-2. Deflections off transect lines indicate relative fish density.

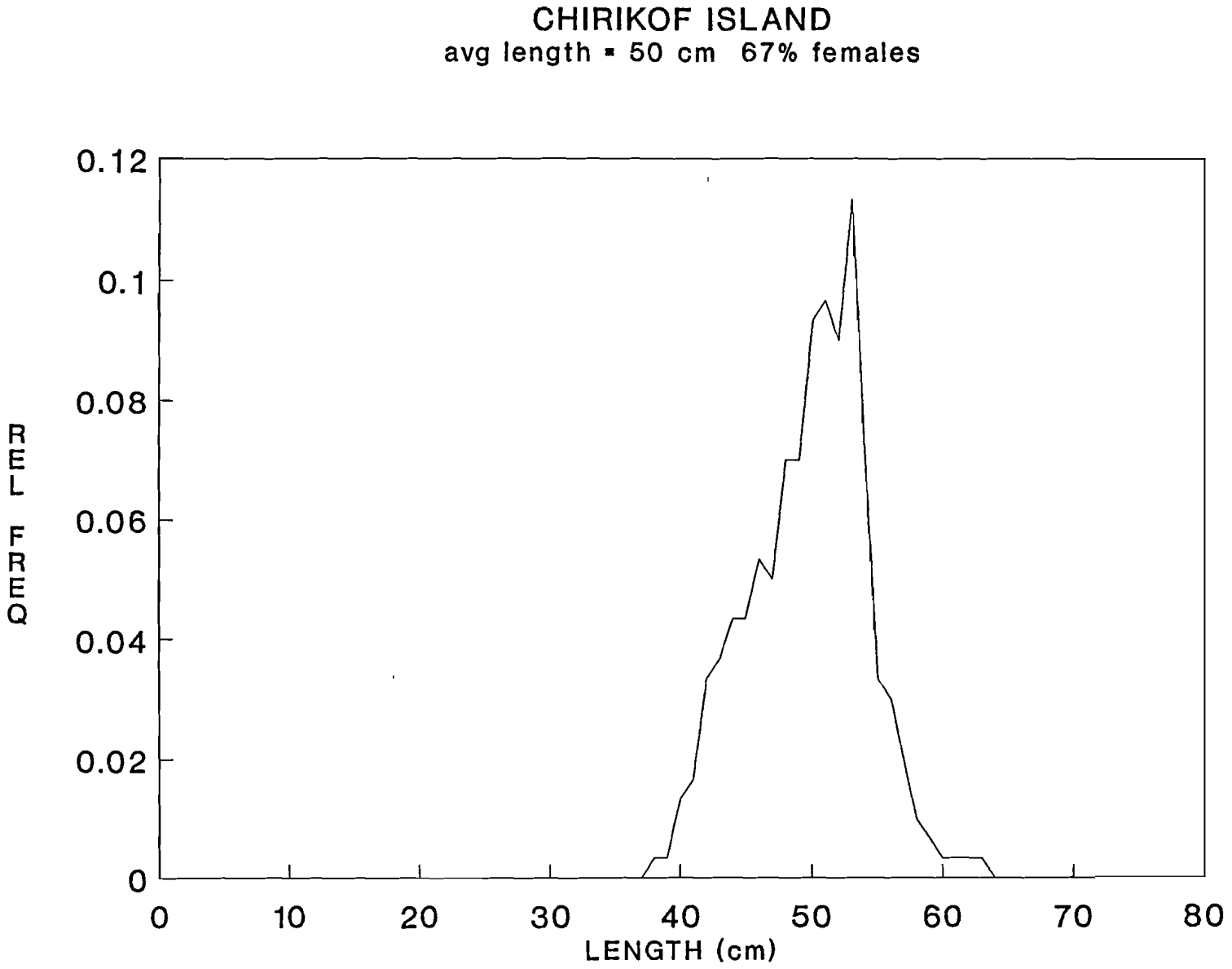
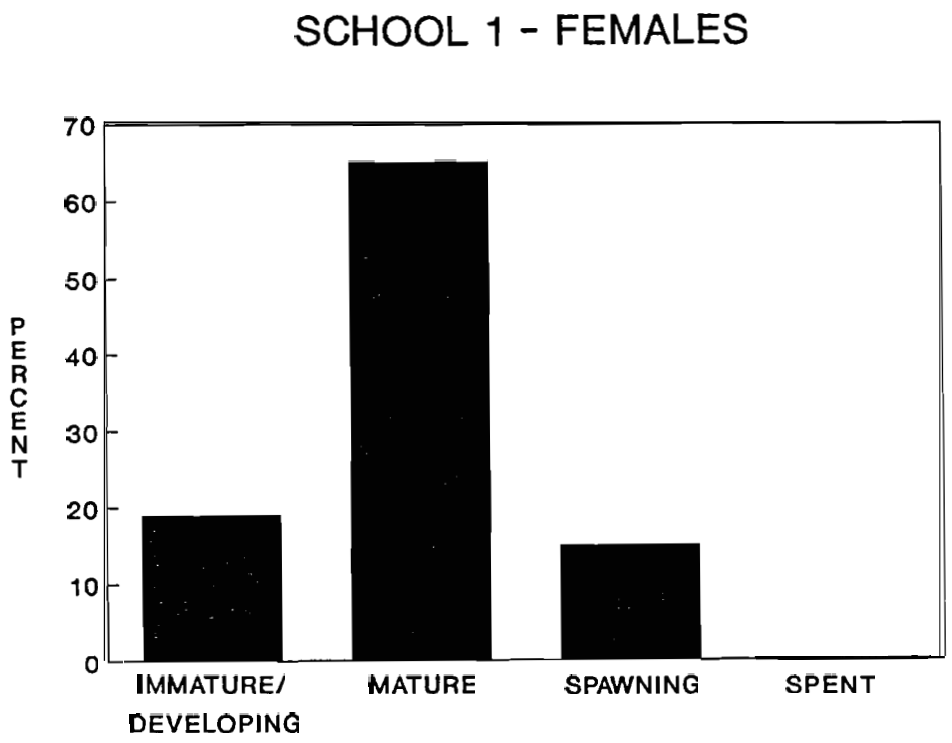


Figure 10. Pollock length distribution (unweighted by population size) in the Chirikof Island area, MF89-2.



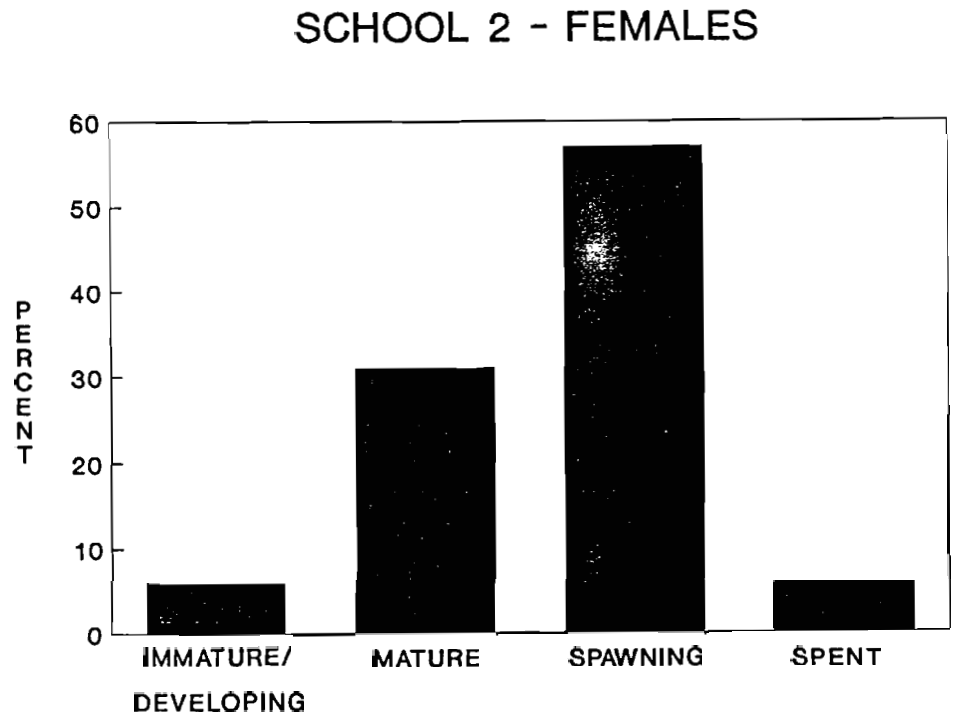


Figure 11. Maturity composition of female pollock from two schools in the Chirikof Island area, MF89-2.

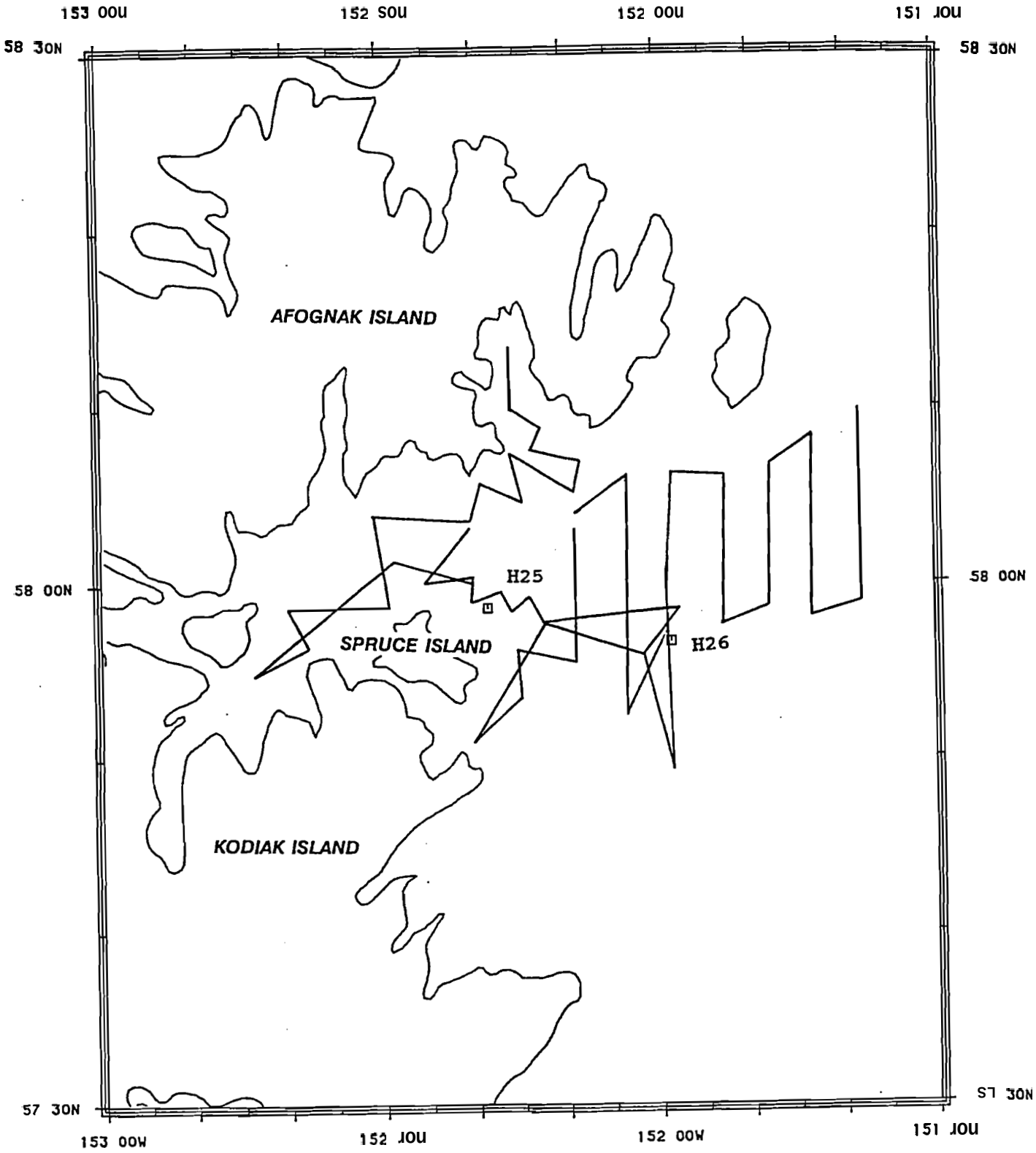
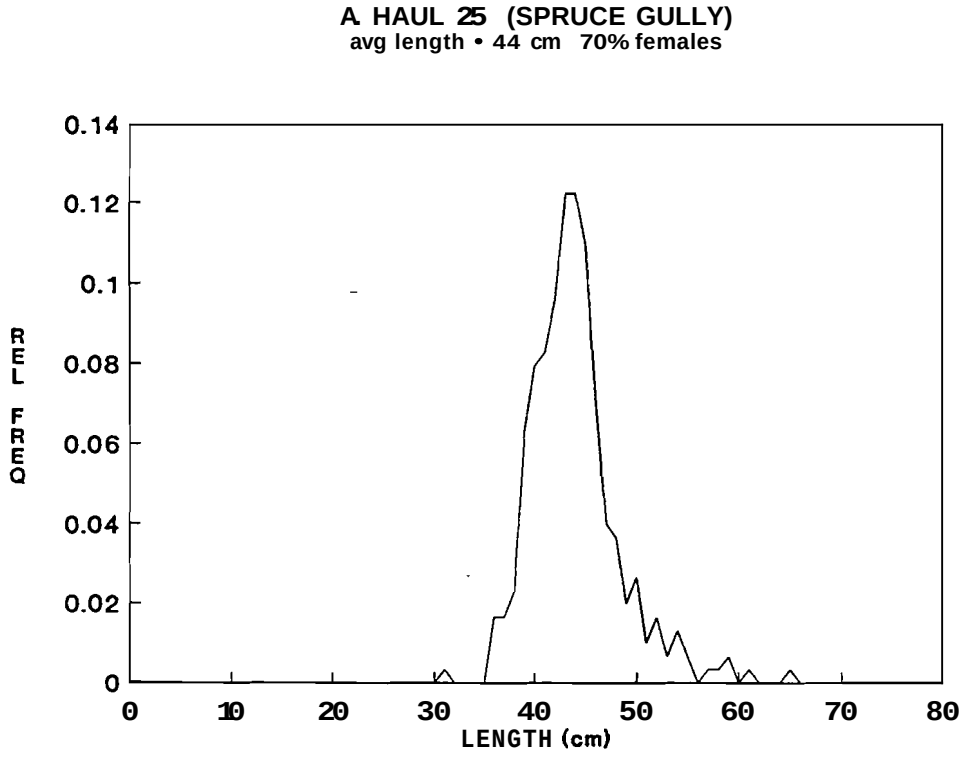


Figure 12. Marmot Bay survey trackline and midwater trawl stations, MF89-2.



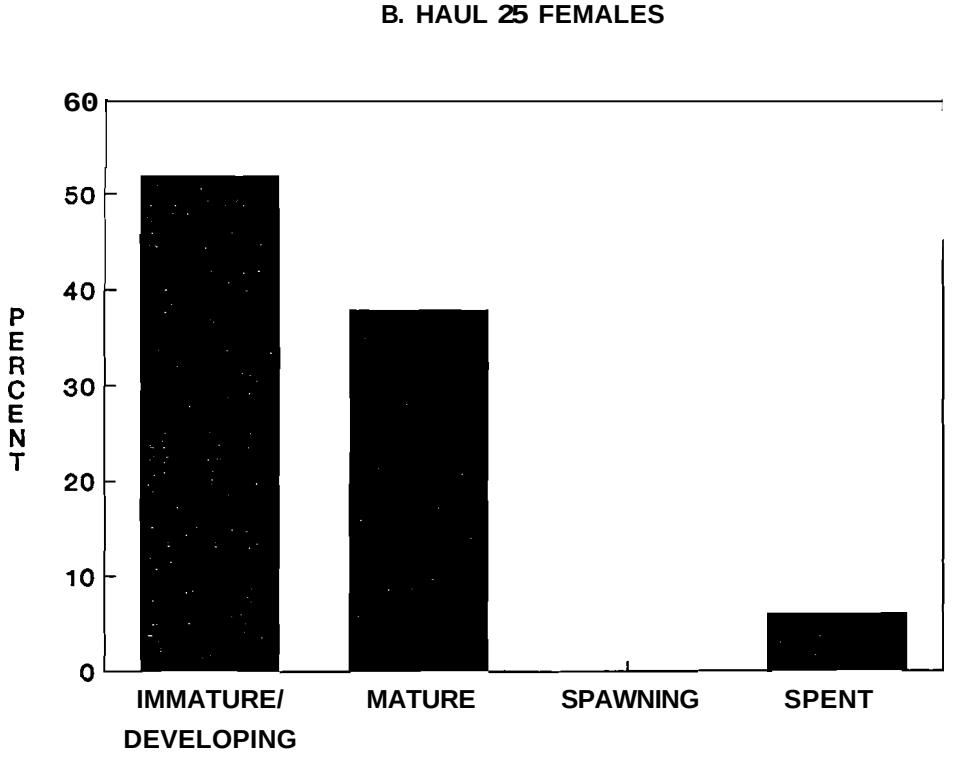
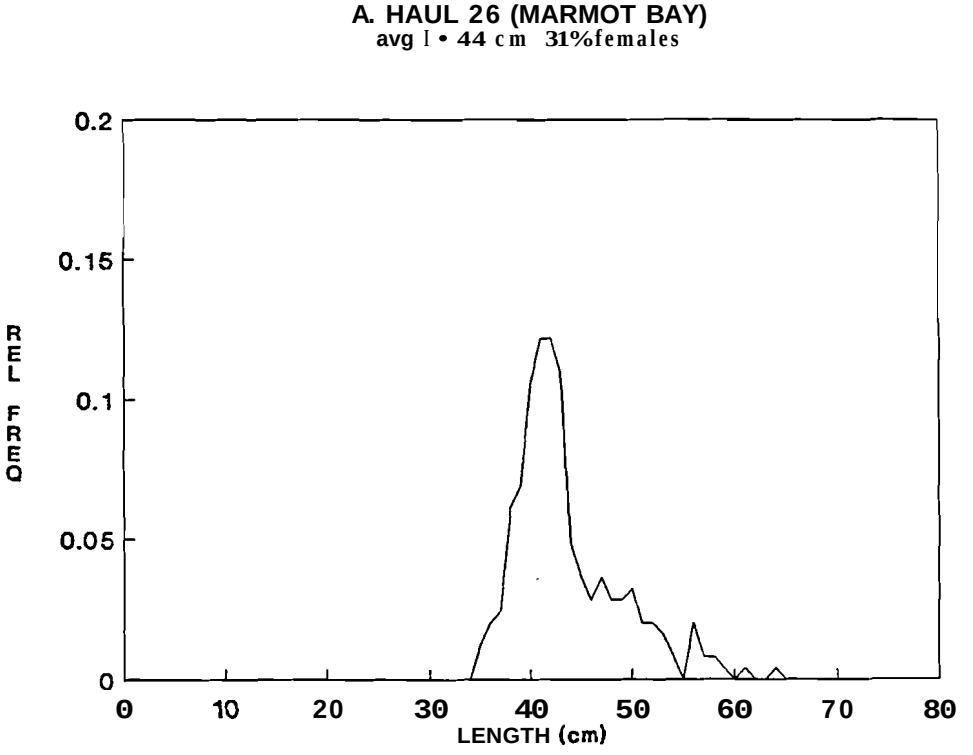


Figure 13. Length composition (A) and female maturity composition (B) for Spruce Gully pollock, MF89-2.



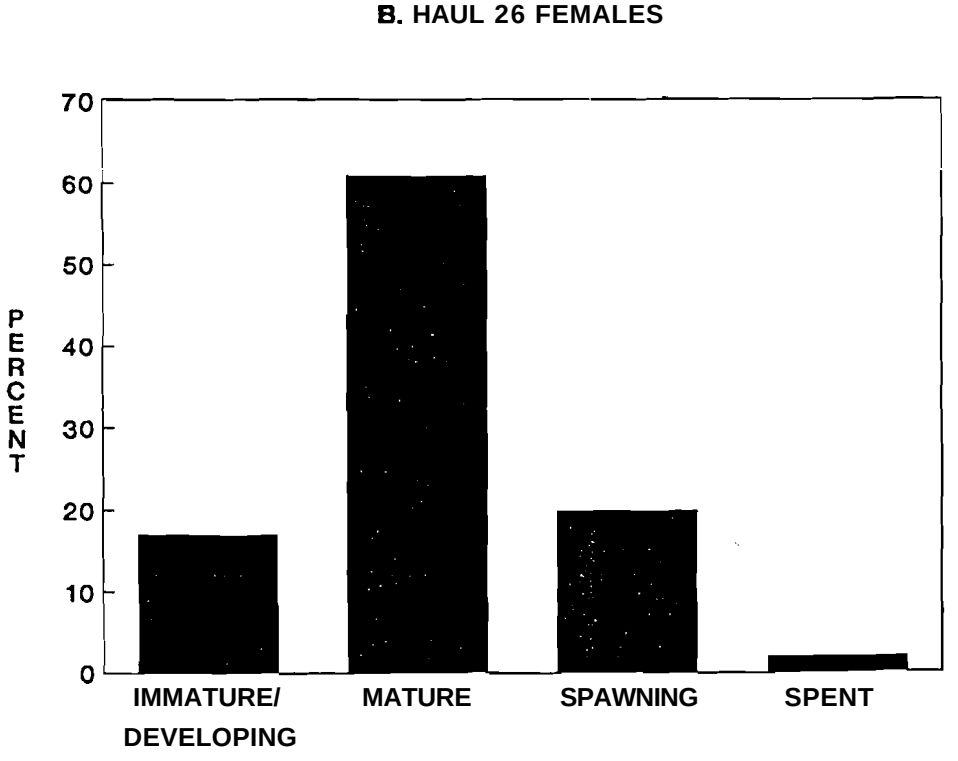


Figure 14. Length composition (A) and female maturity composition (B) for Marmot Bay pollock, MF89-2.

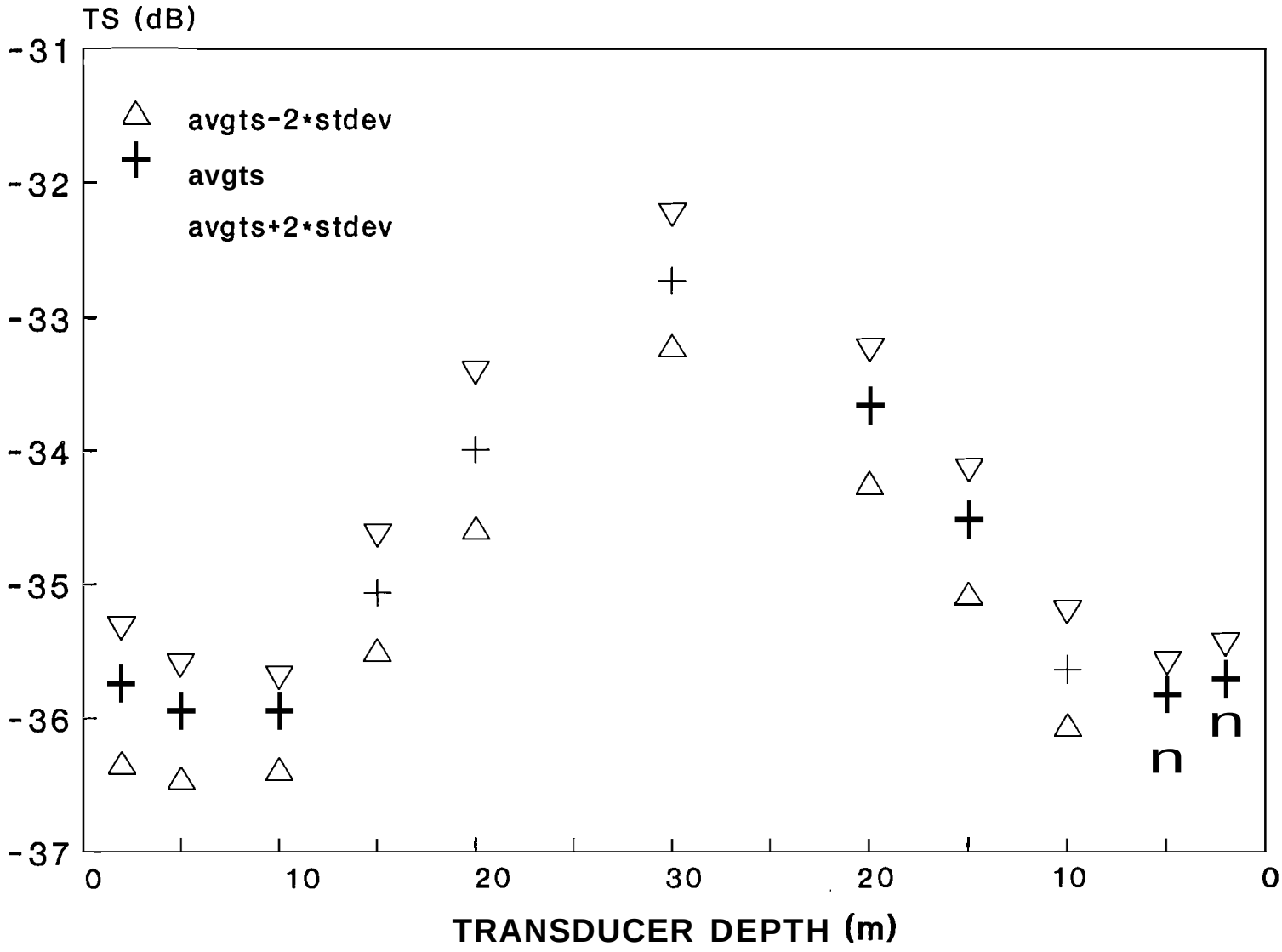


Figure 15. Target strength (dB) of a standard copper sphere at selected transducer depths between 2 and 30 meters.